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PICKERING NGS 1990 VACUUM BUILDING OUTAGE - INSPECTION OF PRESSURE RELIEF VALVE DIAPHRAGMS

Report No. 90-203-K

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Abstract

This report details the inspection of the replacement of both upper and lower neoprene rolling diaphragms with EPDM rolling diaphragms in the pressure relief valves which isolate the atmosphere of the pressure relief duct from that of the vacuum building at Pickering NGS. A total of 12 valves had the diaphragms replaced. On 10 of the 12 valves diaphragms, the baseline durometer hardness levels of the diaphragms were measured. In addition, portions of the replacement process were videotaped and photographed.

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EXECUTIVE SUMMARY

PICKERING NGS 1990 VACUUM BUILDING OUTAGE - INSPECTION OF PRESSURE RELIEF VALVE DIAPHRAGMS

R.J. Lewak

During the 1990 Pickering NGS vacuum building outage, the neoprene rubber rolling diaphragms in the pressure relief valves were replaced by EPDM (Ethylene-Propylene-Diene Monomer) rubber diaphragms. The Chemical Research Department performed inspections on this procedure. The pressure relief valves isolate the vacuum building atmosphere from the pressure relief duct atmosphere. The rolling diaphragms in each valve, one upper and one lower, are intended to provide a friction free seal between the piston and the housing.

Each valve was removed from its receptacle in the PRD and transported to a laydown area just north of the Auxiliary Irradiated Fuel Bay at Pickering NGS where it was disassembled. The old diaphragms were stripped off the piston. The piston surface was ground to bare metal to receive the new diaphragms and then the free ends of the new diaphragms were bonded to the piston and secured by metal bands. The valve was reassembled and then transported back to the PRD where it was installed in its proper receptacle.

Portions of the replacement procedure were photographed and videotaped. In addition, the baseline durometer hardness readings of the diaphragms of ten of the twelve valves were taken. The hardness values were well within the specified limits.

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APPENDICIES

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To

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To: Mr. P. Charlebois
Technical Manager
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PICKERING NGS 1990 VACUUM BUILDING OUTAGE - INSPECTION OF PRESSURE RELIEF VALVE DIAPHRAGMS

R.J. Lewak

1.0 INTRODUCTION

A key component of the safety system at Pickering NGS is the set of twelve pressure relief valves (PRV) which are located in the pressure relief duct (PRD) between Units 1 and 2. Figure 1 shows a cross sectional diagram of a PRV. These valves were installed in parallel in steel receptacles in the path between the vacuum ducts and the PRD. These valves isolate the atmosphere of the PRD from that of the vacuum building during normal operation.

Three of the twelve valves are instrumented for automatic and manual remote control. If at least two out of three pressure switches indicate that the pressure in the PRD is 3.4 kPag or greater all three instrumented valves will be triggered to open. One of the PRVs will try to maintain the PRD pressure at -0.7 kPag, one will try to maintain the PRD pressure at -1.4 kPag and the third will try to maintain the pressure at -2.1 kPag. The instrumented PRVs are operated by controlling the pressure above the piston. The valve can be closed by opening the air-operated valve at the air inlet line and thus connecting the top of the PRV housing to the outside atmosphere. The PRV can be opened (piston lifted) by closing the air-operated valve at the air inlet line and opening the air-operated valve on the line to the controlled vacuum header which is connected to the vacuum building.

If the overpressure inside the PRD is large or fast, the action of the instrumented valves may not be sufficient to limit the overpressure in the PRD. In this case the other nine PRVs open

when the pressure rises to between 4.4 kPag and 4.8 kPag which is sufficient to overcome the weight of the piston.

The PRVs are self actuating piston valves designed for negligible friction between the piston and cylinder. They can be removed on -power by isolating the vacuum building by a water seal by filling the U shaped vacuum ducts with water. As shown in Figure 1, the PRV is 1.8 m (6 ft) in diameter and is constructed of mild steel. The PRV consists of a housing forming a vertical cylinder in which a piston moves up and down. Two elastomeric rolling diaphragms prevent leakage past the piston with minimum friction. An overpressure of 4.4 kPag in the PRD is sufficient to overcome the weight of the piston and the pressure differential on the diaphragms to force the piston up and open the valve. A piston will lift 53 cm to fully open to expose the upper and lower parts of the housing. It will remain in this position until the pressure in the PRD falls below 4.8 kPag and all the non-instrumented valves close by gravity.

Two key components of each PRV are the upper and lower elastomeric diaphragms. Both diaphragms are essentially rubber cylinders, 0.64 cm (0.25 in) thick, with a flange around one end. The top diaphragm, shown in Figure 2, has a diameter of 193 cm (76 in) and length of 51 cm (20 in) with a 7.6 cm (3 in) flange around one end. The bottom diaphragm, shown in Figure 3, has a diameter of 193 cm (76 in) and a length of 94 cm (37 in) with a 15.2 cm (6 in) flange. Both top and bottom diaphragms flanges have 1.75 cm bolt holes for attachment to the PRV housing. The other end of both diaphragms is attached to the PRV piston by **REMA-TECH 2000**^{TM} adhesive and two steel bands. Since one end of the diaphragm is stationary while the other end is bonded to the moving piston the action of the diaphragm is one of a rolling motion in which the bend in the diaphragm changes position along the diaphragm length with piston motion.

2.0 OLD AND NEW PRV DIAPHRAGMS

The old PRV diaphragms had been in operation since 1970 and had been made from two layers of neoprene rubber bonded together on a polyester net. They had been manufactured by Lion Rubber Ltd. of Montreal. These diaphragms had been periodically inspected /1, 2, 3/ with the conclusion that the neoprene rubber had aged and become harder with a loss of flexibility. It was felt that the old diaphragms may not have sufficient flexibility over the time period until the next scheduled Pickering NGS Vacuum Building outage in 2000, therefore, replacement of the diaphragms should occur during the 1990 outage.

The new PRV diaphragms were made by Lion Rubber Ltd. of Montreal to Ontario Hydro specifications from EPDM rubber. EPDM rubber (Ethylene-Propylene-Diene Monomer) was chosen over neoprene rubber for its better aging resistance and over silicone rubber

for its better resistance to wear. The new PRV diaphragms were made from two layers of EPDM rubber bonded together on a polyester net. A great deal of difficulty was encountered with these new diaphragms due to the quality of manufacture. Certain reservations by the Chemical Research Department regarding these diaphragms were made /4/ based on the fact that the first diaphragms delivered by Lion Rubber to PNGS contained multiple delaminations and disbonds of the EPDM layers. Furthermore, any further delamination in the diaphragms could not be detected by simple visual observation once the diaphragms were installed due to the fact that the diaphragms are out of sight except for the flanges. However, after certain assurances by Lion Rubber that the correct number of diaphragms free from defects would be delivered to PNGS before the May 1990 outage were made, the PRV diaphragms replacement went ahead as scheduled. In addition, a close visual examination of each diaphragm was made by representatives of Pickering Engineering prior to its installation so that it would be assured that no defects would be present.

3.0 REPLACEMENT OF PRV DIAPHRAGMS

The first stage in the replacement of the PRV diaphragms was the removal of the PRVs from the PRD to a laydown area north of the Auxilliary Irradiated Fuel Bay (AIFB) located to the west of Unit 4. In this location, work platforms had been constructed and overhead cranes were available for the dismantling and diaphragm replacement of up to three PRVs at the same time. Portions of the PRV were dismantled in the PRD as shown in Figure 4, which shows the removal of the top vent pipe from the housing. The PRV was removed from the receptacle in the PRD floor and was removed from the PRD through the equipment airlock in the floor of the PRD as shown in Figure 5. It was then transported to the AIFB at which time further disassembly occurred as shown in Figure 6.

Once installed in the AIFB on a work platform, the process of PRV disassembly began. Figure 7 shows the components of a PRV during this process. Then the old diaphragms were removed as shown in Figure 8. The adhesive bond between the old diaphragms and the pistons was strong enough that portions of the neoprene rubber still remained bonded to the pistons as shown in Figures 9 and 10. Once the old diaphragms were stripped from the piston, the piston surface to which the new diaphragms would be bonded were ground down to bare metal as shown in Figure 11. Following the grinding the new diaphragms were attached to the piston. Figures 12 and 13 show a lower diaphragm being fitted onto a piston. Figure 14 shows a close-up of the lower diaphragm. The bond to the piston is located in the area of the steel retaining bands. Figure 15 shows the diaphragm from another angle and shows how it has already been curved back upon itself so that the rolling action can occur. The upper diaphragm, as shown in Figure 16, shows how the diaphragm is bonded to the piston and secured by

steel bands. Figures 17, 18, and 19 show further reassembly of the PRV after which it is transported back to the PRD, moved into the PRD by the equipment airlock and further reassembled in position in the PRD.

4.0 BASELINE MEASUREMENTS ON NEW DIAPHRAGMS

Either during the installation procedure or after, when the PRVs were reinstalled in the PRD, the Shore A hardness of the upper and lower diaphragms were measured. These values are:

PRV	Upper Diaphragm	Lower Diaphragm
1	68, 62, 65	58, 52, 57
2	68, 67, 63	58, 52, 55
3	68, 62, 63	60, 55, 65
4	----------	----------
5	61, 62, 63	55, 54, 57
6	62, 61, 60	58, 55, 60
7	----------	----------
8	65, 63, 68	58, 58, 56
9	60, 60, 58	60, 55, 65
10	65, 65, 65	55, 65, 60
11	65, 65, 55	58, 60, 65
12	58, 65, 65	58, 55, 60

The hardness readings were taken on the exposed surface of the upper diaphragm. On the lower diaphragm the hardness gauge was inserted through the opening and taken on the not visible surface inside the PRV. These measurements are only to be used for comparison with similar measurements at later times as the support surface for the measurements is not uniform and not standard.

5.0 VIDEO RECORDING

The procedure of the PRV diaphragm replacement has been recorded on videotape. Unfortunately, due to scheduling differences, the entire procedure from start to finish could not be recorded. Instead, a few key sequences of the procedure have been recorded. Equipment difficulties with the camcorder also prevented the imaging of each PRV diaphragm in its finished condition.

The videotapes are being kept on file in the Materials Chemistry Section of the Chemical Research Department.

6.0 ACKNOWLEDGEMENT

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3. Pressure Relief Valve Seal Inspection of Valves 10 and 11 at Pickering NGS, R.W. Winn, Chemical Research Department Report C89-42-K, Apr. 1989.

4. Memorandum from R.J. Lewak to N. Yousef, "Replacement of PRV Diaphragms During 1990 Pickering NGS Outage", April 30, 1990, File: 835.613.

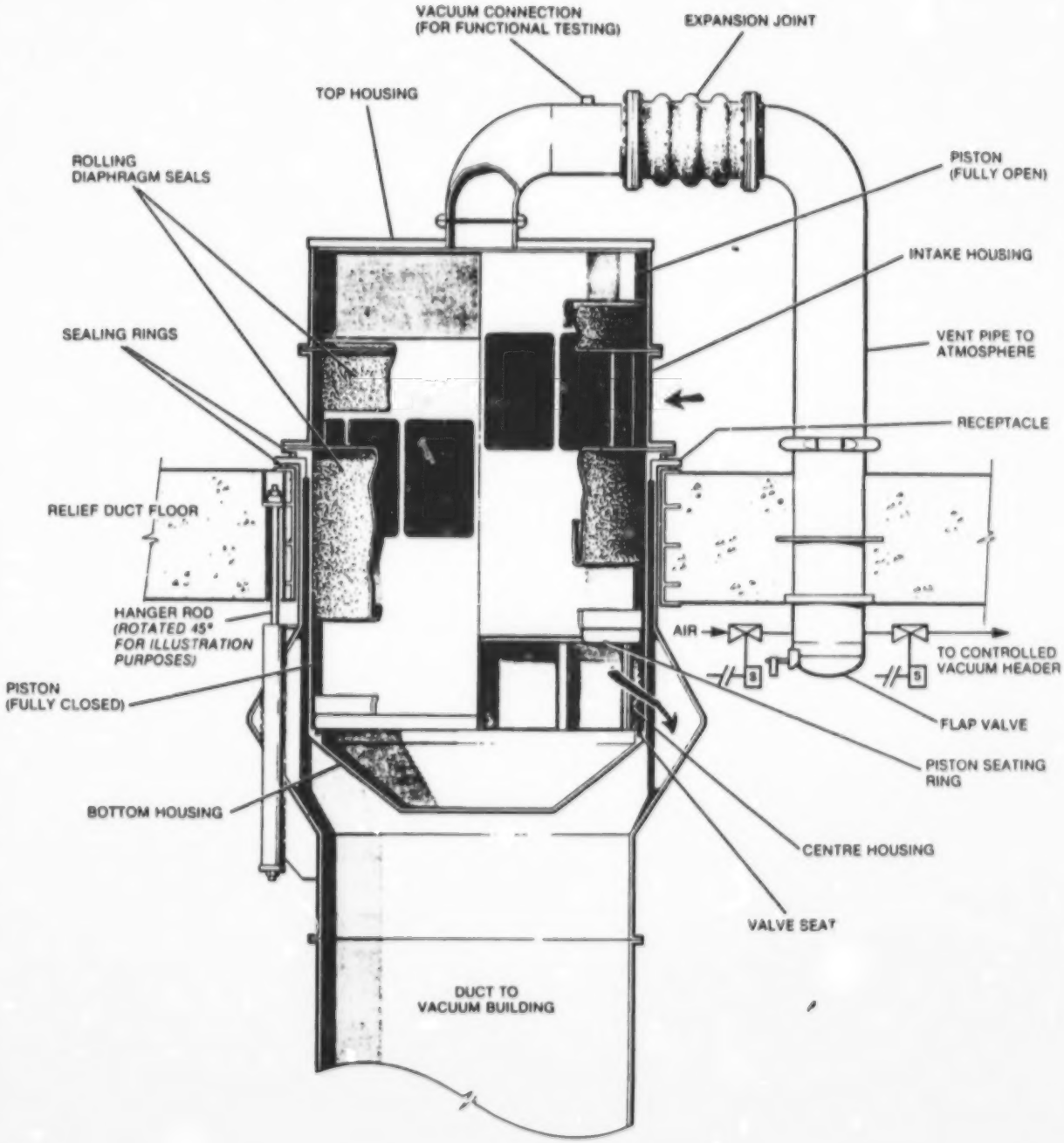
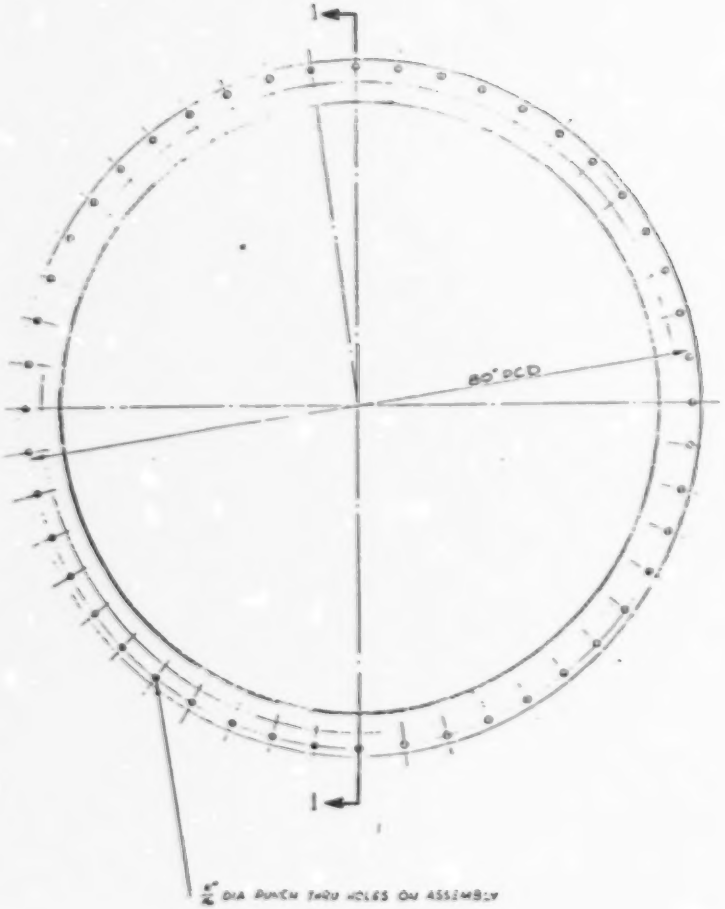
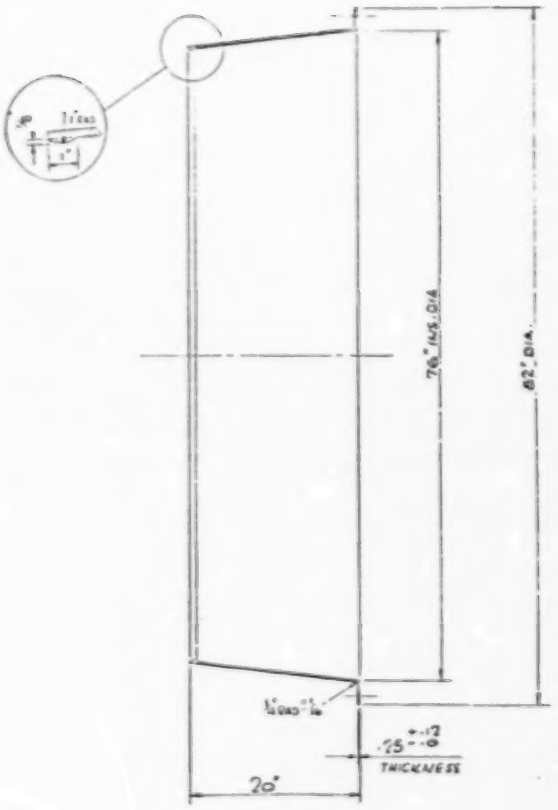


FIGURE 1

Pressure Relief Valve





SECTION 1-1

FIGURE 2

Top Diaphragm

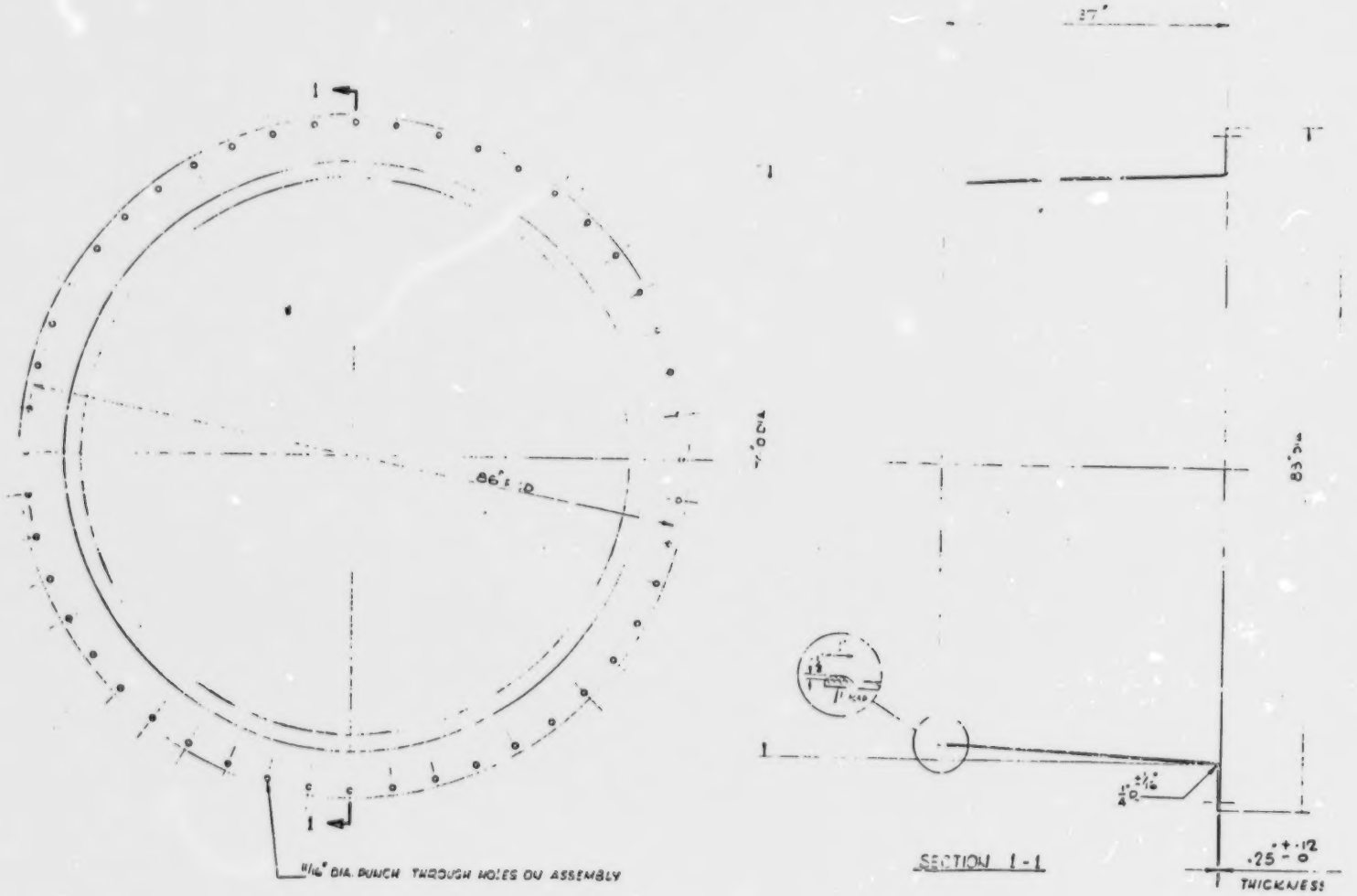


FIGURE 3

Bottom Diaphragm

FIGURE 4

Dismantling PRV in PRD

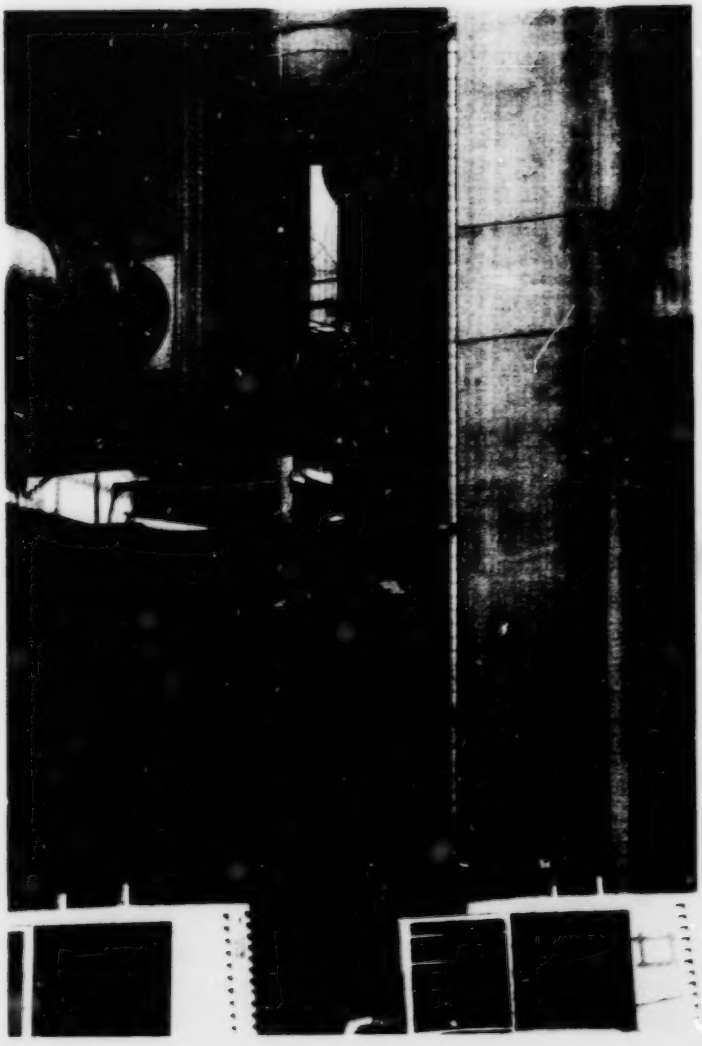


FIGURE 5

PRV Removed from PRD

FIGURE 6

PRV Transported to AIFB

FIGURE 7

Disassembled Components of PRV

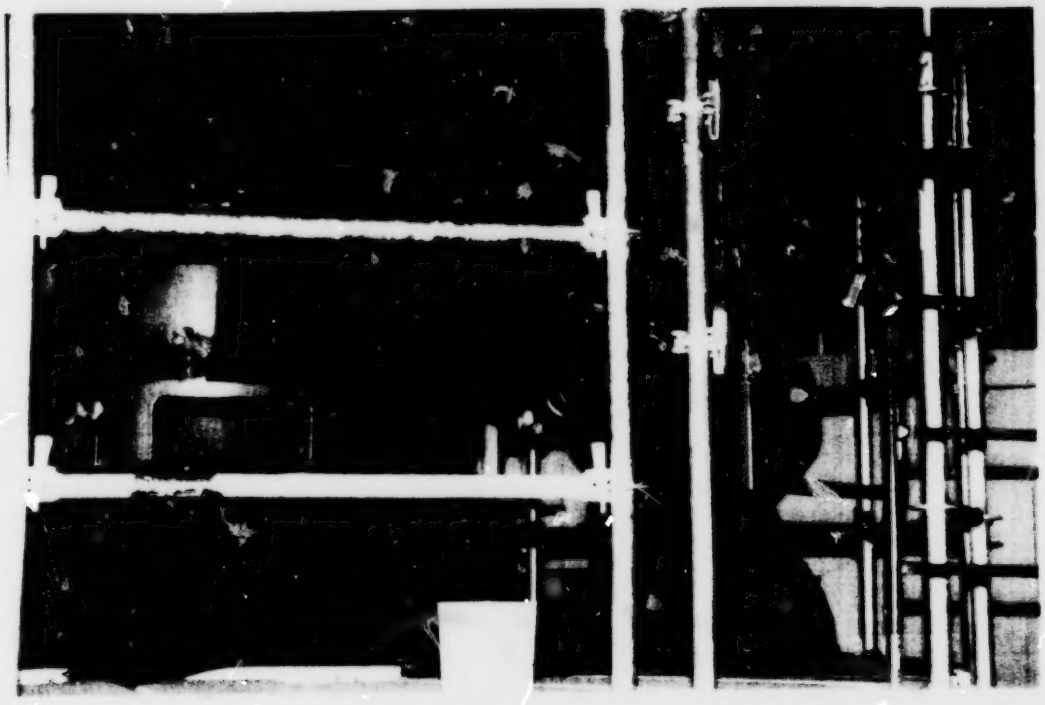


FIGURE 8

Removing Old Diaphragms

FIGURE 9

Rubber Still Bonded to Piston

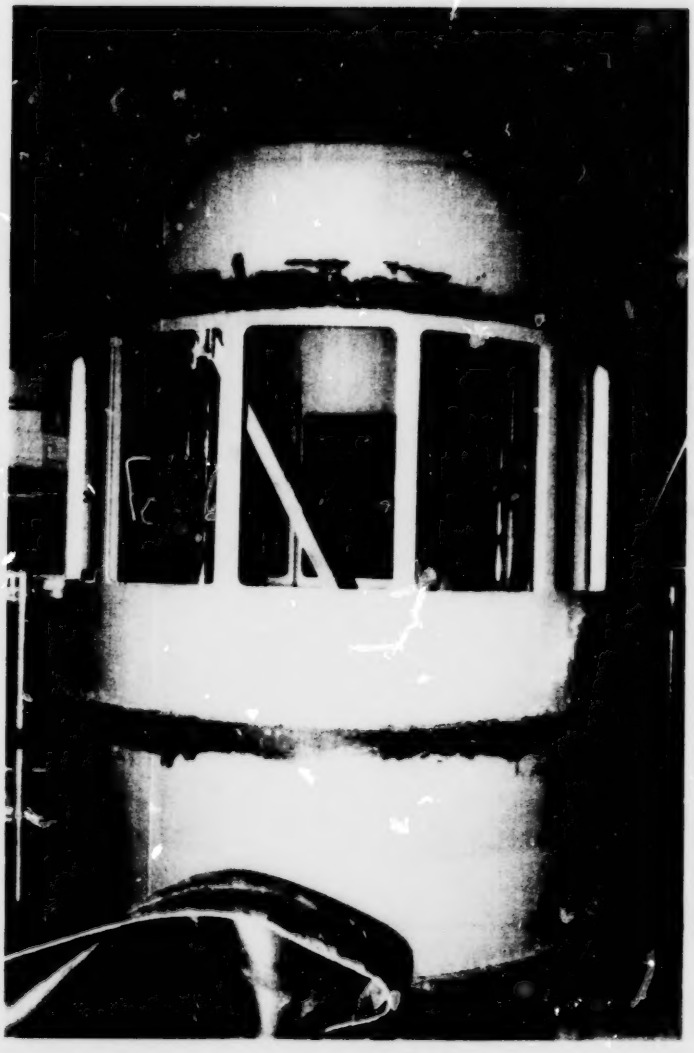


FIGURE 10

Rubber Still Bonded to Piston

FIGURE 11

Grinding Piston to Bare Metal

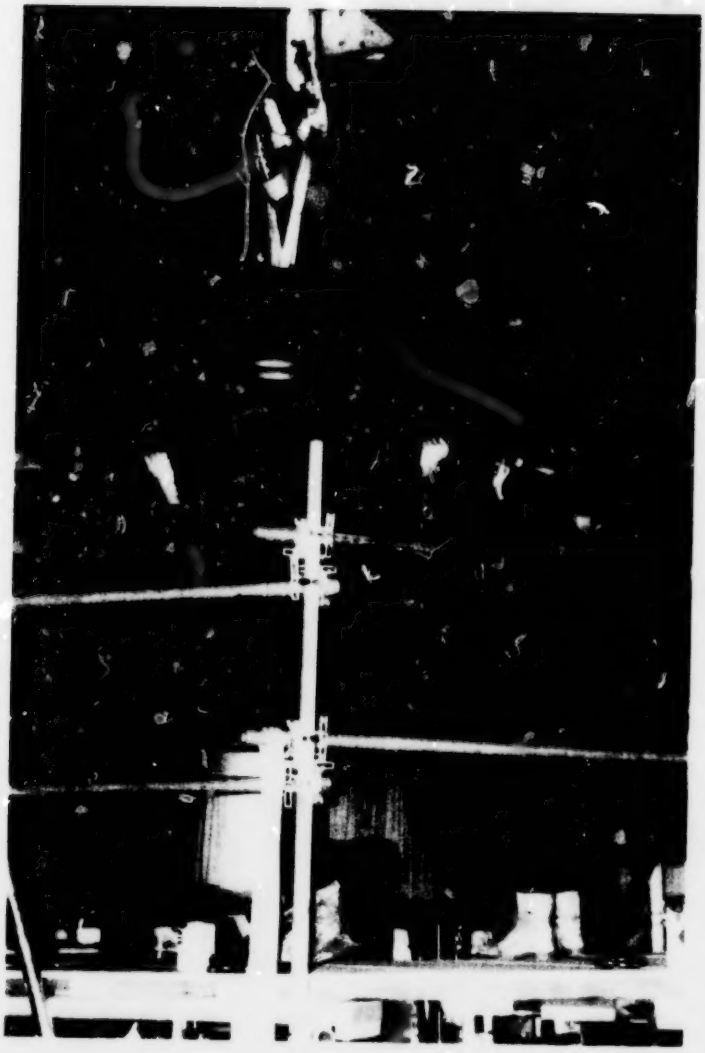


FIGURE 12

Fitting Lower Diaphragm to Piston

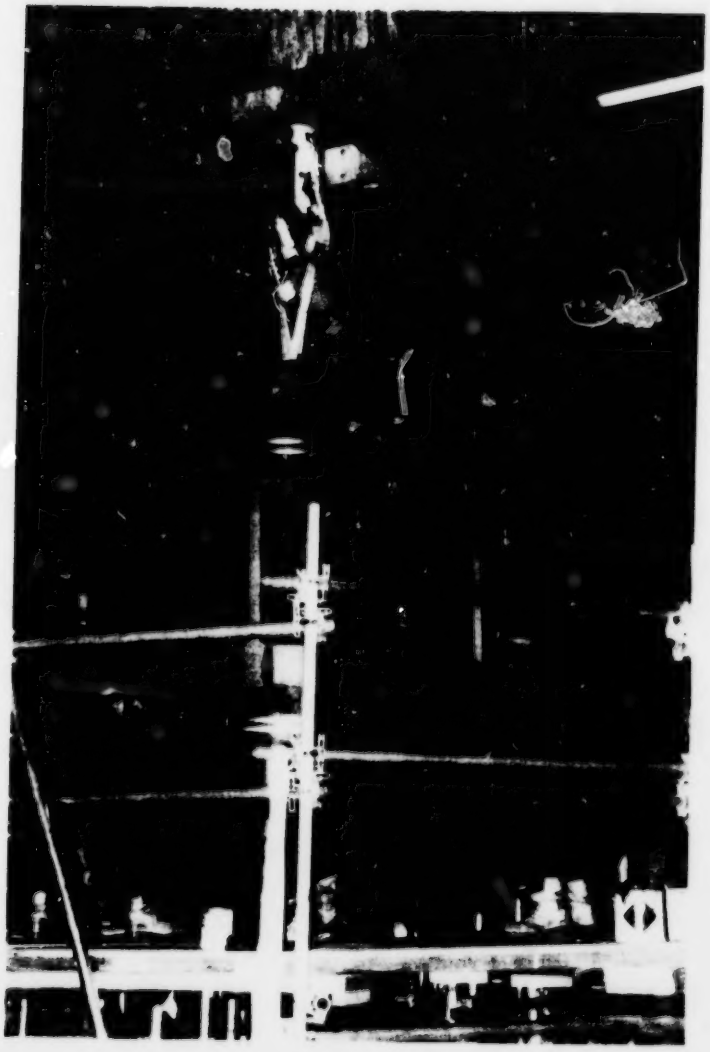


FIGURE 13

Fitting Lower Disphragm to Piston

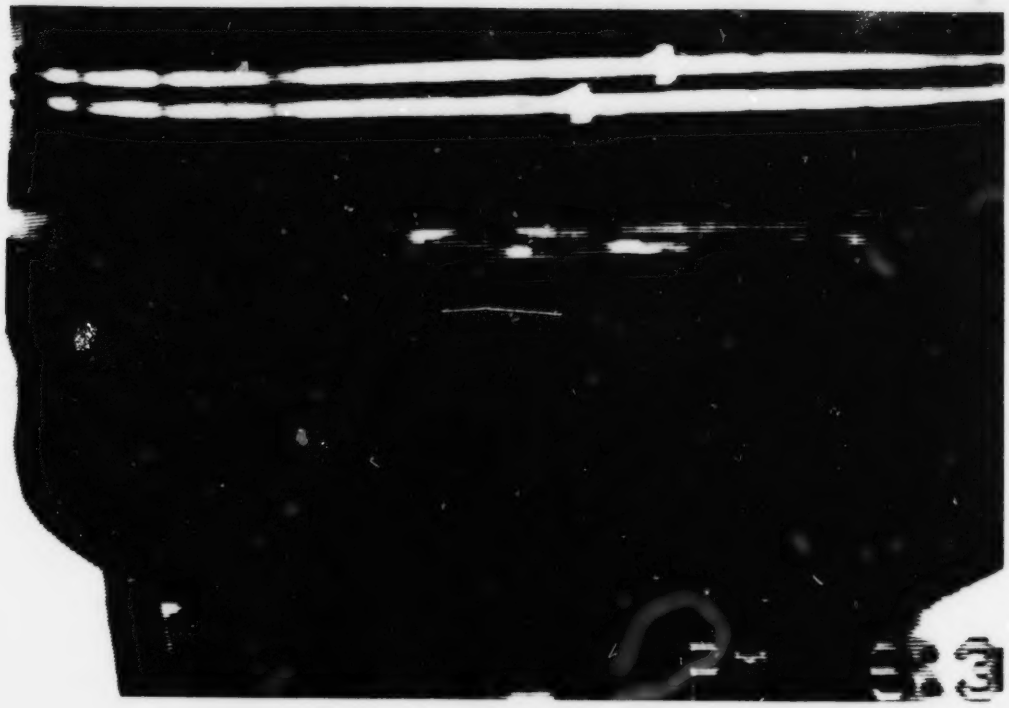


FIGURE 14

Lower Diaphragm

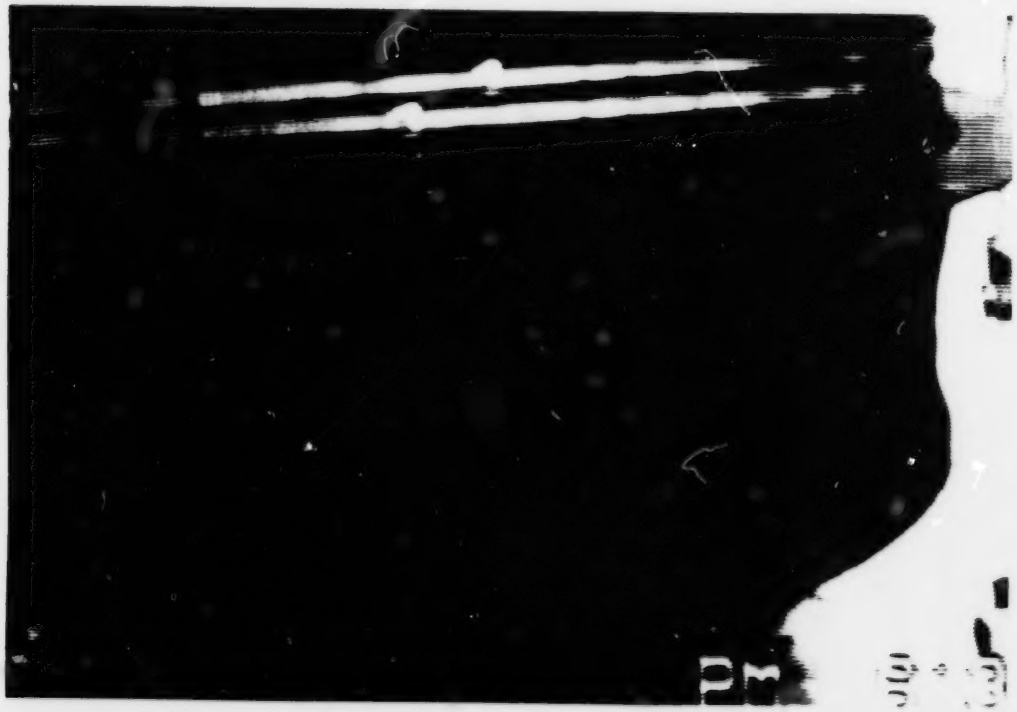


FIGURE 15

Lower Diaphragm

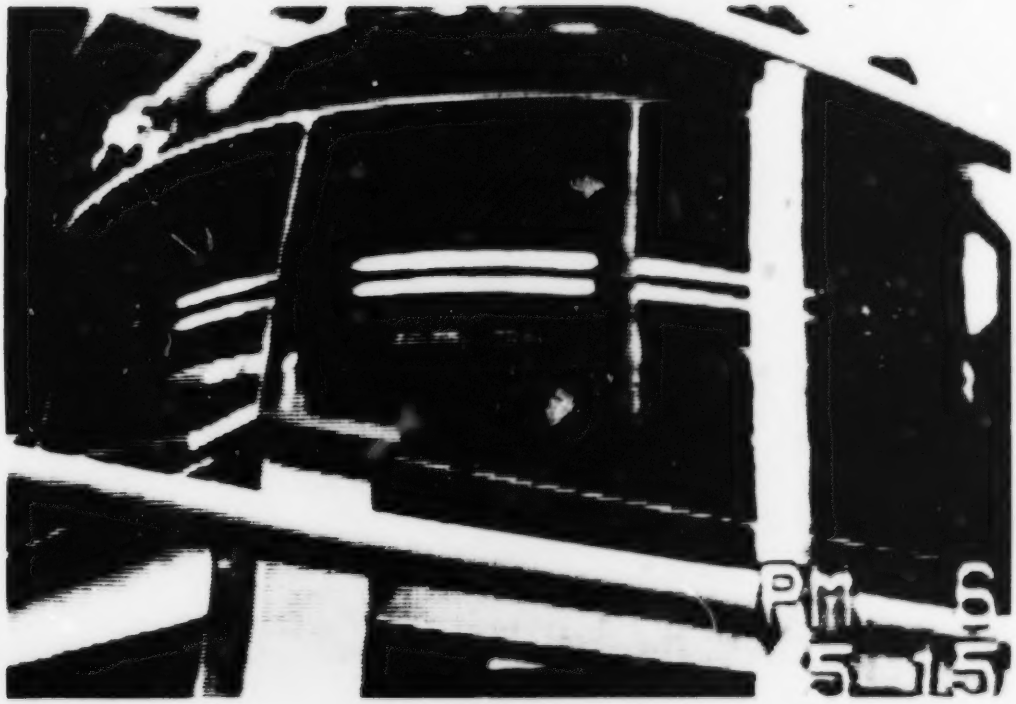


FIGURE 16

Upper Diaphragm

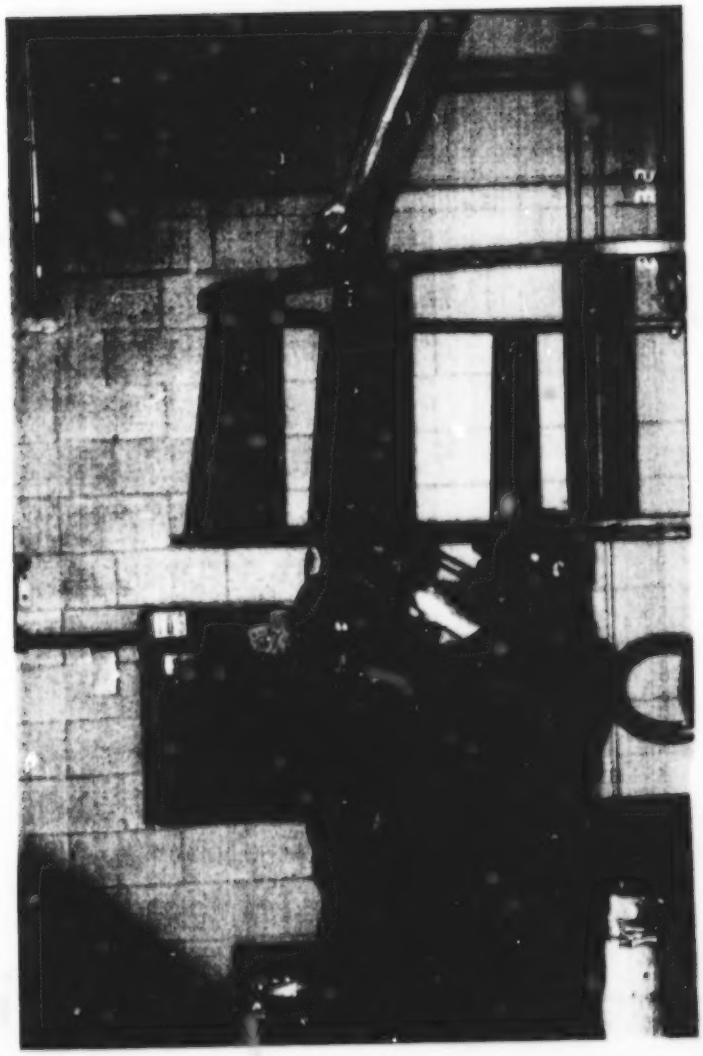


FIGURE 17

PRV Reassembly

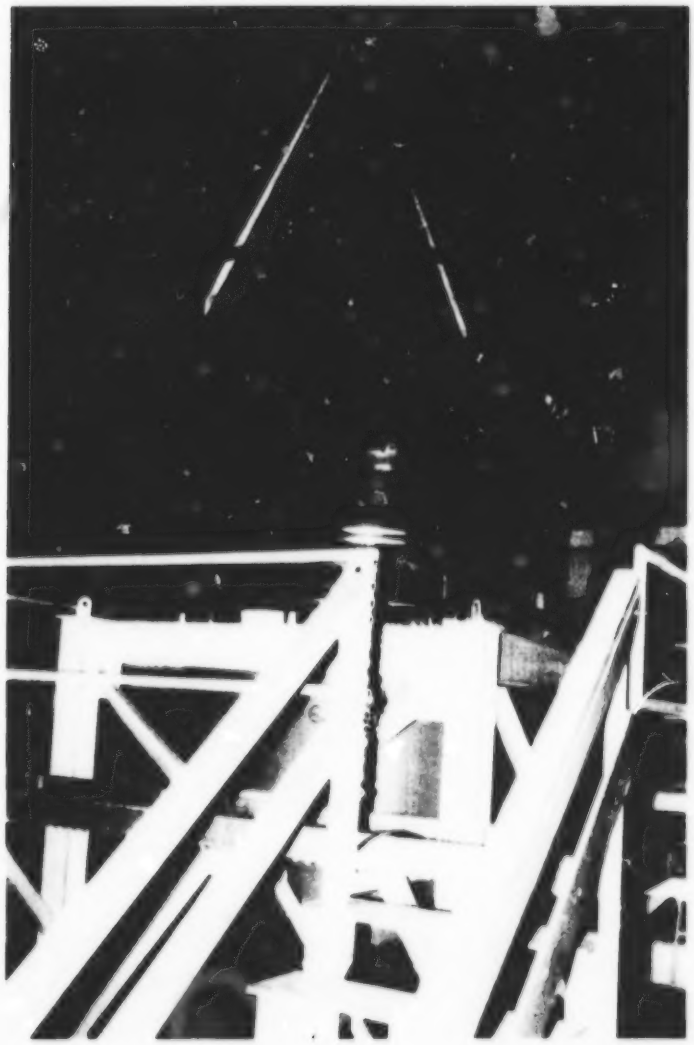


FIGURE 18

PRV Reassembly

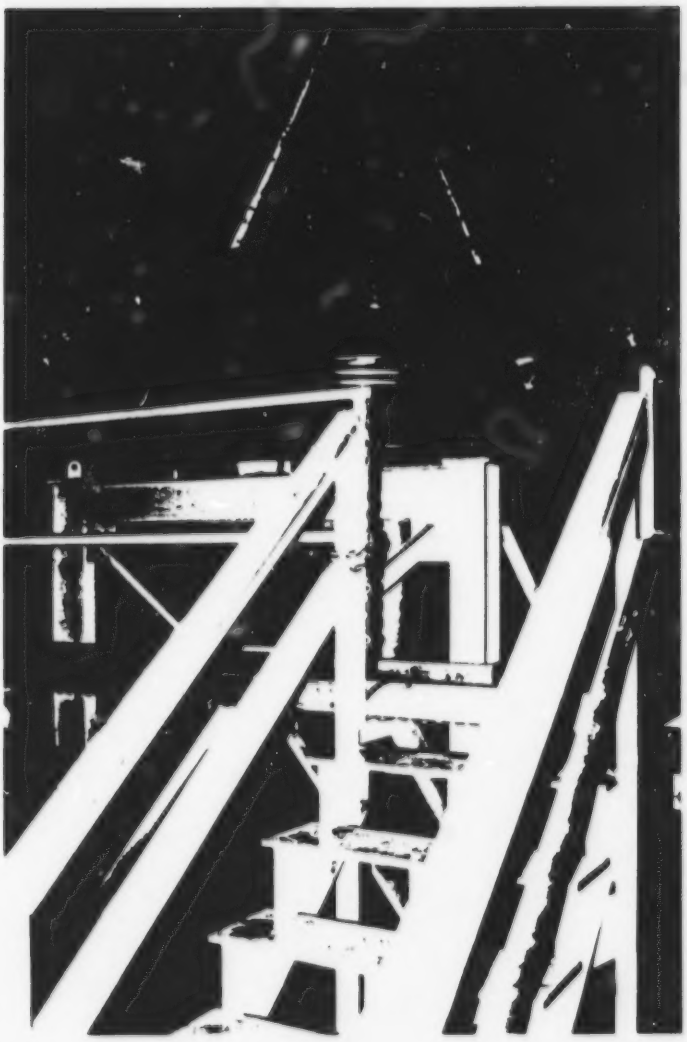


FIGURE 19

PRV Reassembly